

## PNEUMATIC ASSEMBLY FOR A PAINTBALL GUN

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This application is a continuation-in-part of U.S. Patent Application Serial No. 10/695,049, filed October 27, 2003, the contents of which are incorporated herein by reference in their entirety.

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### BACKGROUND OF THE INVENTION

#### Field of the Invention

This invention relates generally to pneumatic paintball guns (“markers”) and their operating components. More particularly, this invention relates to pneumatic components used to load and fire paintball markers.

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#### Related Art

In the sport of paintball, it is generally desirable to have a marker that is as small and light as possible. Smaller and lighter markers increase a players’ mobility. Players benefit from increased mobility by being able to move more quickly from bunker to bunker, making it easier to avoid being hit. Further, in the sport of paintball, the marker is treated as an extension of the body such that a hit to the marker counts as a hit to the player. It is desirable, therefore, to have a paintball gun with as small a profile as possible while substantially maintaining or improving performance characteristics of the marker, such as firing rate, accuracy, and gas efficiency. The size of the paintball gun is generally related to the size and number of operating components that must be housed within the paintball gun body.

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### SUMMARY OF THE INVENTION

In one embodiment of the present invention, a pneumatic assembly for a paintball gun includes a compressed gas storage chamber and a bolt. The storage chamber can be configured to receive a regulated supply of compressed gas. The bolt is preferably configured to slide back and forth between an open (preferably rearward) and a closed (preferably forward) position to load a paintball into a breech of the paintball gun and to control the release of compressed gas from the compressed gas storage area into the bolt to launch the paintball.

To reduce the size and complexity of the paintball gun, the bolt can be configured to provide the firing mechanism of the pneumatic assembly. More particularly, one or more ports are preferably disposed through a lateral wall of the bolt at a predetermined distance from an end of the bolt. The bolt port(s) are preferably arranged to selectively permit the transfer of  
5 compressed gas into the bolt from a compressed gas storage area. Most preferably, the bolt port(s) are configured to convey compressed gas into the bolt when the bolt is disposed in a closed position, but not when the bolt is in an open position. This can be accomplished in any number of different ways.

For example, a sealing member can be arranged in communication with the bolt at a  
10 predetermined distance from a front portion of the assembly. The sealing member preferably keeps compressed gas from passing through the bolt port(s) into the bolt when the bolt is in an open position. In a closed position, however, compressed gas is allowed to pass through the port(s) into the bolt and then out bolt release ports on the front of the bolt to launch a paintball.

In one specific embodiment, for example, the bolt can be arranged on a valve stem. A  
15 sealing member is preferably arranged on a forward end of the valve stem in communication with an internal surface of the bolt. In another embodiment, a sealing member could be arranged in communication with an external surface of the bolt at a predetermined distance from the front of the assembly. As the bolt travels toward its closed position, the bolt port(s)  
20 preferably slide past the sealing member and permit compressed gas to flow from the compressed gas storage area into the bolt.

According to another aspect of the present invention, a paintball gun preferably includes a body having a breech. A pneumatic assembly is arranged in the body and preferably includes a compressed gas storage chamber and a bolt. The bolt is preferably configured to move to a closed position in the breech to move a paintball into a firing position and to cause compressed  
25 gas to be released through the bolt into the breech.

Interchangeable compressed gas storage chambers can be provided having varying internal volumes. These chambers can be color-coded and/or provided with other visual indicia that correspond to their volumes. A viewing aperture can be provided through a lateral wall of the paintball gun body to permit viewing of the storage chamber or other internal components.  
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The paintball gun may also include a control valve, such as an electronic solenoid valve or a mechanical valve configured to initiate forward movement of the bolt in response to a trigger pull. The control valve can also be used to control rearward movement of the bolt. An

electronic eye can also be arranged in the paintball gun in a manner such that no external wiring is required.

According to still another aspect of the present invention, a pneumatic assembly for a paintball gun can use a controlled volume of compressed gas to launch a paintball. This can be  
5 accomplished, for instance, by supplying the compressed gas to the compressed gas storage chamber through a gas supply port arranged in an internal bolt guide. When the bolt is in a rearward position, bolt apertures communicate compressed gas from the supply port to the compressed gas storage chamber. At the same time, one or more sealing members prevent compressed gas from escaping from the bolt. When the bolt is in a forward position, one or  
10 more sealing members preferably substantially cut off the supply of compressed gas from the supply port to the compressed gas storage chamber. At the same time, the compressed gas in the storage chamber is released through the bolt apertures to launch a paintball.

Other embodiments can also provide a controlled quantity of compressed gas to launch a paintball. For example, compressed gas can be supplied to a compressed gas storage chamber  
15 of a pneumatic assembly through a gas supply port in the pneumatic assembly when a bolt is in a rearward position. A sealing member can be provided to substantially cut off the supply of compressed gas to the storage chamber when the bolt is in its forward position.

In one such embodiment, the sealing member can be arranged around the bolt, with the gas input port arranged near a forward portion of the pneumatic assembly. When the bolt is  
20 closed, gas is prevented or restricted from entering the compressed gas storage chamber. When the bolt is open, gas from the supply port is free to enter the compressed gas storage area. As an added benefit of this configuration, gas from the supply port can assist in opening the bolt for a loading operation.

Bolt ports for communicating compressed gas from the compressed gas storage chamber  
25 during a firing operation can be configured to permit an internal bolt area to function as part of the compressed gas storage area. Elongated bolt ports and/or additional bolt ports, for instance, can be configured to permit communication between an intermediate area, located between the bolt and the bolt guide, and the compressed gas storage chamber during a firing operation. The elongated bolt ports could, for example, extend beyond opposite sides of a sealing member. An  
30 increased volume of gas can thereby be made available to fire the paintball gun, enabling operation at lower pressure, without an increase in the overall size of the pneumatic assembly.

Various other aspects, embodiments, and configurations of this invention are also possible without departing from the principles disclosed herein. This invention is therefore not limited to any of the particular aspects, embodiments, or configurations described herein.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and additional objects, features, and advantages of the present invention will become more readily apparent from the following detailed description of preferred embodiments, made with reference to the accompanying figures, in which:

10 FIG. 1A is a cross-sectional perspective view of a paintball gun body and pneumatic assembly, with a bolt thereof in an rearward (e.g., open) position, according to certain principles of the present invention;

FIG. 1B is a cross-sectional perspective view of the paintball gun body and pneumatic assembly of FIG. 1A, wherein the bolt is disposed in a forward (e.g., closed) position;

15 FIG. 2A is a cross-sectional side view of the paintball gun body and pneumatic assembly of FIG. 1A;

FIG. 2B is a cross-sectional side view of the paintball gun body and pneumatic assembly of FIG. 1B;

FIG. 3A is a cross-sectional side view of a paintball gun employing the paintball gun body and pneumatic assembly shown in FIG. 1A;

20 FIG. 3B is a cross-sectional side view of a paintball gun employing the paintball gun body and pneumatic assembly shown in FIG. 1B;

FIG. 4 is a perspective view of a paintball gun body illustrating further principles of the present invention;

25 FIG. 5 is a cross-sectional view of a pneumatic assembly for a paintball gun according to another embodiment employing principles of the present invention;

FIG. 6 is a cross-sectional view of a pneumatic assembly for a paintball gun according to a still further embodiment employing principles of the present invention; and

FIG. 7 is a cross-sectional view of the pneumatic paintball gun assembly of FIG. 6, showing the bolt in a forward (e.g., closed) position.

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#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The accompanying drawings show the construction of various preferred embodiments incorporating principles of the present invention. Referring first to FIGS. 1A, 1B, 2A, and 2B, a pneumatic assembly 10 for a paintball gun is preferably configured to be housed within a single chamber or bore of a paintball gun body 110. The pneumatic assembly 10 preferably includes a compressed gas storage chamber 12 configured to store compressed gas for a firing operation, and a pneumatic cylinder 14. A bolt 20 preferably extends longitudinally through at least a portion of the compressed gas storage chamber 12. The bolt 20 can be coupled to, or formed integrally with, a piston 24 that is slidably arranged in the pneumatic cylinder 14. The bolt 20 can be slidably mounted on a bolt guide (or valve stem) 16 and preferably comprises one or more ports 22 arranged through a lateral sidewall 21 of the bolt 20. The valve stem 16 can comprise a sealing member 18 arranged on a forward end 16a thereof.

In this embodiment, when the bolt 20 is open (e.g., rearward), as shown in FIGS. 1A and 2A, the sealing member 18 prevents compressed gas from flowing through the bolt ports 22 into the bolt 20. When the bolt 20 is closed (e.g., in a forward position), as shown in FIGS. 1B and 2B, however, compressed gas from the compressed gas storage chamber 12 is permitted to flow through the bolt ports 22 into a forward area 20a of the bolt 20. Movement of the pneumatic piston 24, and hence movement of the bolt 20, can be controlled by directing compressed gas to, and venting compressed gas from, alternating sides of the pneumatic piston 24 through cylinder ports 14a, 14b. A vent 16d can be provided through a rearward end of the valve stem 16 (or other location) to prevent pressure build-up behind the bolt 20.

Referring now to FIGS. 3A and 3B, operation of a paintball gun 100 employing the pneumatic assembly 10 shown in FIGS. 1A through 2B is as follows. When the bolt 20 is rearward, a paintball (not shown) is permitted to drop into the breech area 110a of the paintball gun body 110. A mechanical or electrical pneumatic valve 30 (e.g., an electronic solenoid valve) preferably initiates a firing operation in response to a pull on the trigger 42. During the firing operation, the pneumatic piston 24 moves forward under control of the pneumatic valve 30 by directing compressed gas to a rearward cylinder port 14b while venting compressed gas from a forward cylinder port 14a.

The bolt 20 is carried forward by the forward movement of the pneumatic piston 24. As the bolt 20 moves forward, the paintball is loaded into a firing position in a barrel 120, which communicates with the breech area 110a of the paintball gun body 110. At the same time, the

bolt ports 22 slide past the sealing member 18 and an internal chamber 20a of the bolt 20 is exposed to the compressed gas in the compressed gas storage chamber 12. Compressed gas thereby flows through the bolt ports 22, into the bolt 20, and through gas release ports 25 to launch the paintball.

5 According to this embodiment, the bolt 20 of the pneumatic paintball gun 100 preferably provides the firing mechanism. More specifically, the bolt ports 22, formed through the bolt wall 21 at a predetermined position along the bolt 20, are configured to selectively permit and prevent compressed gas from entering the forward bolt area 20a. This is preferably accomplished by positioning the ports 22 in a desired relation with respect to the sealing  
10 member 18. When the bolt 20 is open, a sealing engagement between the bolt 20 and the sealing member 18 preferably prevents compressed gas from entering the ports 22. When the bolt 20 closes, however, the ports 22 preferably transmit compressed gas from the compressed gas storage area 12 into the forward bolt chamber 20a. The compressed gas then flows out the release ports 25 to launch a paintball.

15 In embodiments in which the bolt 20 is slidably mounted on a valve stem 16, a sealing member 18 (such as an O-ring, plug, or any other sealing structure) is preferably arranged at a forward end 16a of the valve stem 16. The sealing member 18 thereby preferably prevents compressed gas from entering the bolt 20 from the compressed gas storage area 12 until the bolt 20 reaches a predetermined forward position. As the bolt 20 approaches its predetermined  
20 forward position, the bolt ports 22 slide past the sealing member 18 and expose an internal bolt chamber 20a to compressed gas from the storage chamber 12.

It should be noted, however, that many alternative embodiments are possible without departing from the inventive principles disclosed herein. In one alternative embodiment, for example, a sealing member can be arranged in communication with an external surface 21b (see  
25 FIG. 1B) of the bolt 20. As in the earlier embodiment, the sealing member (not shown) could be configured to prevent compressed gas from entering the bolt 20 from a compressed gas storage area 12 until the bolt 20 reaches a closed position. As the bolt closes, the gas entry ports 22 preferably slide past the sealing member to permit compressed gas to enter the bolt 20 to launch the paintball from the marker.

30 Referring to FIGS. 1A-3B, movement of the bolt 20 is preferably accomplished using an electronic solenoid valve 30. The bolt 20 can, for instance, include two, oppositely arranged piston surface areas 24a, 24b formed on a rearward portion of the bolt 20. The solenoid valve

30 can then be configured to alternately supply compressed gas to and vent compressed gas from the two surface areas 24a, 24b. More particularly, compressed gas is preferably supplied from the solenoid valve 30 to a forward surface area 24a through a forward port 14a and vented from a rearward surface area 24b through a rearward port 14b to move the bolt 20 to a rearward position. Compressed gas is preferably supplied to the rearward surface area 24b through the rearward port 14b and vented from the forward surface area 24a through a forward port 14a to move the bolt 20 to a forward position.

Although this configuration preferably uses a single, four-way solenoid valve, various types, numbers, and configurations of solenoid valves can be used to shuttle the bolt between a forward and rearward position. In one alternative embodiment, for instance, pressure from a constant supply of compressed gas (or a spring or other biasing member applying a known force) can be provided to a first piston surface area, with compressed gas being selectively supplied through a three-way solenoid valve to an opposite surface having a sufficient area to operate the bolt. Furthermore, the bolt could be connected to a separate pneumatic piston rather than having piston surface areas formed directly thereon.

Referring now to FIGS. 3A and 4, a paintball gun body 110, can embody various additional inventive principles. In particular, the paintball gun body 110 shown in FIG. 4 preferably includes a viewing aperture 112 arranged through a lateral wall 111 of the paintball gun body 110. A detent aperture 114 can be provided for placement of a ball detent to prevent paintballs from double feeding. An eye aperture 116 can also be provided through the body wall 111 for the positioning of an electronic eye (not shown). The electronic eye preferably senses the presence or absence of a paintball in the breech area 110a (or the transition of a paintball into the breech area 110a) of the paintball gun body 110 to prevent misfiring or breaking a paintball in the breech. An internal wiring aperture 116a can also be provided from the breech area 110a to a grip 111 of the paintball gun 100 to permit attachment of the electronic eye to a circuit board 50 of the paintball gun 100 without any external wiring.

According to yet another aspect of this invention, a plurality of compressed gas storage chambers 12 can be provided, with each of the compressed gas storage chambers 12 having a different internal volume from the others. Different internal volumes may be desirable to permit firing of a paintball at a desired velocity using a different gas pressure. Selecting an appropriate chamber volume can also improve gas efficiency. In one embodiment, each of the plurality of compressed gas storage chambers 12 can be provided having a different color, an externally

visible sticker or markings, or other size indicator(s) 12a to represent an internal volume of the chamber 12. When the chamber 12 is arranged in the paintball gun body 110, this indicator 12a can preferably be viewed through the viewing aperture 112 to permit quick visual determination of the internal volume of the compressed gas storage chamber 12. The indicators 12a can, for  
5 instance, indicate an actual volume, a relative volume (as compared to other chambers or some independent reference value), or both.

FIG. 5 is a cross-sectional view of a pneumatic assembly 10A for a paintball gun 100 (see FIG. 3A) constructed according to an alternative embodiment of the invention. Referring to FIG. 5, a pneumatic assembly 10A according to this embodiment preferably provides a fixed-  
10 volume firing chamber 12 to reduce gas consumption and increase the overall efficiency of the paintball gun 100. As in the embodiments described previously, the pneumatic assembly 10A preferably includes a compressed gas storage chamber 12 and a pneumatic cylinder 14 having a piston 24 slidably arranged therein. A bolt 20 is preferably disposed through the compressed gas storage chamber 12 and coupled to (or formed integrally with) the piston 24. The bolt 20  
15 can be slidably mounted on a valve stem (or bolt guide) 16. The valve stem 16 preferably comprises a sealing member 18 arranged on a forward end 16a thereof. The bolt 20 preferably comprises one or more ports 22 arranged through a lateral sidewall 21 of the bolt 20.

Unlike the previous described embodiments, however, compressed gas is preferably supplied to the compressed gas storage chamber 12 through the valve stem 16. The valve stem  
20 16 of this embodiment preferably receives compressed gas into an internal passageway 16c from a compressed gas source (such as a regulator) through an input port 15. The input port 15 can be arranged in the rearward end of the pneumatic assembly 10A. The compressed gas travels down the passageway 16c and through output ports 16h into an intermediate area 12a located between the bolt 20 and the valve stem 16.

25 When the bolt 20 is in a rearward position, compressed gas is allowed to travel from the intermediate area 12a into the compressed gas storage chamber 12 through the bolt ports 22. When the bolt transitions to its forward position, however, the supply of compressed gas to the compressed gas storage chamber 12 is preferably cut off (or restricted) as the bolt ports 22 slide past the sealing member 18. At this same time, the compressed gas in the storage chamber 12 is  
30 released through the bolt ports 22 into and through the bolt 20. In this manner, a controlled amount of compressed gas can be used to launch a paintball from the paintball gun 100 and gas efficiency can be improved.

FIG. 6 is a cross-sectional view of a pneumatic assembly 10B for a paintball gun 100 (see FIG. 3A) according to yet another embodiment of the present invention. Referring to FIG. 6, a pneumatic assembly 10B according to this embodiment also preferably includes a compressed gas storage chamber 12 and a pneumatic cylinder 14 having a piston 24 slidably arranged therein. A bolt 20 is preferably disposed through the compressed gas storage chamber 12 and coupled to (or formed integrally with) the piston 24. The bolt 20 can be slidably mounted on a valve stem (or bolt guide) 16. The valve stem 16 preferably comprises a sealing member 18 arranged on a forward end 16a thereof. The bolt 20 preferably comprises one or more ports 22 arranged through a lateral sidewall 21 of the bolt 20. With the bolt 20 in a rearward position, compressed gas is preferably supplied to the compressed gas storage chamber 12 through an input port 15 located near a forward end of the pneumatic assembly 10B. A vent 16d can be provided to release pressure behind the bolt 20.

FIG. 7 is a cross-sectional view of the pneumatic assembly 10B of FIG. 6, showing the bolt 20 in a forward position. Referring to FIG. 7, when the bolt 20 approaches its forward position, a sealing member 23 arranged around a lateral sidewall 21 of the bolt 20 preferably seals off the compressed gas storage chamber 12 from the gas input 15 (or at least substantially restricts a flow of compressed gas into the storage chamber 12). At the same time, at least a portion of the bolt ports 22A slide past the sealing member 18 arranged on the valve stem 16, thereby releasing compressed gas through the bolt 20 and out of the bolt ports 25 to launch a paintball.

Compressed gas supplied through the gas input 15 can also be used to assist in opening the bolt 20 following a firing operation to provide a faster loading operation. For example, in the pneumatic assembly 10B shown in FIG. 7, differential pressures are applied to the sealing member 23 after the compressed gas is evacuated from the storage area 12. The differential pressures create a rearward force on the sealing member 23 that assists in opening the bolt 20 during a loading operation. This results in a faster loading operation and can thereby enable an increased firing rate.

According to still other principles of this invention, an increased area can be provided for supplying the compressed gas for the firing operation without increasing the external dimensions of the firing chamber 12. In the pneumatic assembly 10B of this embodiment, for example, the bolt ports 22A are preferably formed so as to enable an intermediate area 12a located between the internal bolt surface 21a and the valve stem 16 to supply a portion of the

compressed gas for the launching operation. More particularly, with the bolt 20 arranged in its forward position, the bolt ports 22A are preferably formed as slots, holes, or other shapes that extend from one side of the sealing member 18 to the other, thereby enabling communication between the intermediate area 12a, the compressed gas storage chamber 12, and the bolt release ports 25. Alternatively, additional, separate bolt ports can be provided to permit communication between the intermediate area 12a and the compressed gas storage chamber 12. In this manner, the size of the compressed gas storage chamber 12 can be effectively enlarged without changing its external dimensions. By increasing the volume of the compressed gas storage chamber 12, a lower chamber pressure is required to fire the paintball at the desired velocity.

Having described and illustrated various principles of the present invention through descriptions of exemplary preferred embodiments thereof, it will be readily apparent to those skilled in the art that these embodiments can be modified in arrangement and detail without departing from the inventive principles made apparent herein. The claims should therefore be interpreted to cover all such variations and modifications.

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